REMARKS

By the present amendment, claims 1 and 2 are under consideration in the application. Claim 6 has been withdrawn due to the restriction requirement.

If claim 1 is found allowable, it is respectfully requested that dependent claim 6 be rejoined to the application.

Amendments To The Claims

In claims 1 and 2, the limitation --strengthen by TiC and/or NbC precipitates-- is disclosed in the specification, e.g., at page 6, lines 12 to 29.

Ti and/or Nb are very important elements in the present invention and are effective for securing strength through the precipitation of TiC and/or NbC in the structure of the steel.

In claims 1 and 2, the upper limit of the Al content in the steel of the present invention of --0.04%-- is supported in the specification wherein "0.04% Al" is the maximum Al in the inventive examples, in Table 1, page 13, i.e., Steel Examples A to D and F to Z. Note that Steel Example E having "0.4% Si" is outside the scope of the present invention as claimed in independent claims 1 and 2.

In claims 1 and 2, --adding no Mg--, is supported in the specification wherein page 7, line 20 of the specification discloses that Mg is only optional; see phrase "When added, Mg ...". In Table 1, page 13, Mg is not present in Steel Examples A to S.

In claims 1 and 2, the limitation --at least one of Cu: 0.1 to 1.5% and Ni: 0.1 to 1.0%-- are disclosed in the specification, e.g., at page 3, lines 26 to 31 and page 7, line 36 to page 8, line 8.

§103

Claims 1 and 2 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 2001-342543 alone or in view of U.S. Patent No. 5,470,529 to Nomura et al.

This rejection, as applied to the amended claims, is respectfully traversed.

The Present Invention

The present invention provides, as claimed in the amended claim 1, a high-strength hot-rolled steel sheet having ferritic structure strengthen by TiC and/or NbC precipitates and adding no Mg excellent in hole expandability and ductility, consisting essentially of in terms of mass %:

C: 0.01 to 0.09%, Si: 1.2 to 1.5%, Mn: 0.5 to 3.2%, Al: 0.003 to 0.04% P: 0.03% or below, S: 0.005% or below, Ti: 0.10 to 0.25%, Nb: 0.01 to 0.05%, at least one of Cu: 0.1 to 1.5% and Ni: 0.1 to 1.0%, and the balance consisting of iron and unavoidable impurities, and satisfying all of the following formulas <1> to <3>:

$0.9 \leq 48/12 \times C/Ti < 1.7$ . . . <1>

$50,227 \times C - 4479 \times Mn > -9860$ . . . <2>

$811 \times C + 135 \times Mn + 602 \times Ti + 794 \times Nb > 465$ . . . <3>, and

having strength of at least 980 N/mm^2, and as claimed in the amended claim 2, further consisting essentially of at least one of Mo: 0.05 to 0.40% and V: 0.001 to 0.10%, and satisfying all of the following formulas <1>' to <3>':

$0.9 \leq 48/12 \times C/Ti < 1.7$ . . . <1>'

$50,227 \times C - 4479 \times (Mn + 0.57 \times Mo + 1.08 \times V) > -9860$

. . . <2>'

$811 \times C + 135 \times (Mn + 0.57 \times Mo + 1.08 \times V) + 602 \times Ti + 794 \times Nb > 465$

. . . <3>',

and having strength of at least 980 N/mm^2.

In order to provide a high-strength hot-rolled a steel sheet with hole expandability and ductility having a strength of at least 980 N/mm^2, the present inventors discovered the following technical concepts; 1) sufficiently forming a ferrite structure to enhance ductility, 2) suppressing generation of hard structures such as martensite structure and bainite structures to enhance hole expandability, 3) strengthening ferrite structure by precipitation strengthening (TiC and/or NbC), without adding Mg.

In order to realize the above concept, the present invention controls the contents of the components of the steel so that the contents satisfy the formulas <1> to <3> and strengthens ferrite structure by Ti and/or Nb carbide precipitation.

In particular, both ductility and hole expandability are improved by controlling the content of C, which increases strength by carbide precipitation while deteriorating hole expandability, and the content of Mn, which increases strength while deteriorating elongation, through formula <3>.

It is a remarkable effect of the present invention that a steel excellent in both ductility and hole expandability can be obtained by strengthening ferrite structure by controlling the contents of the components of the steel through formula <3> without adding Mg.

Patentability

Japan No. 2001-342543 ("JP '543")

The steel sheet disclosed in JP '543 secures strength of the 590 to 780 N/mm^2 class, hole expandability and ductility by requiring adding of Mg to the steel.

The steel of JP '543 has a bainite in the structure and secures strength by the bainite structure.

Further, JP '543 discloses that Mg is one of the most important elements in the invention of JP '543.

JP '543 discovered that Mg, when added, forms oxides combining with oxygen, and the fining of MgO or composite oxides of Al_2O_3, SiO_2, MnO, and TiO_2 containing MgO formed at this time results in a small size of each of oxides and a distribution state of even dispersion compared with a steel without adding Mg (Paragraph [0023]] of JP '543).

JP '543 discloses that Ti and Nb are one of the most important elements in JP '543. JP '543 states that it is believed that Ti and Nb precipitate on, among the oxides finely and evenly precipitated, particularly small MgO or composite oxides mainly composed of $MgAl_2O_4$ as nuclei, due to precipitation on such oxides, the precipitates increase in size and have functions to assist fine voids of MgO or $MgAl_2O_4$ to be formed. Further, it is effective for increase strength. (Paragraph [0025] of JP '543).

That is, in JP '543, Ti and Nb precipitates are oxides finely precipitating with Mg, and these precipitates enhance strength of the steel sheet. JP '543 does not disclose or suggest strengthening a ferrite structure by TiC and/or NbC precipitates.

On the contrary, the steel sheet of the present invention is a steel sheet in which the ferrite is precipitation - strengthened by using TiC and/or NbC, and the precipitation of TiC and/or NbC plays essential roles. The mechanism for strengthening the structure is completely different in the present invention as compared to JP '543.

Further, the steel sheet of the present invention contains either one or both of Cu: 0.1 to 1.5% and Ni: 0.1 to 1.0%.

However, the steel sheet of JP '543 does not contain Cu and/or Ni.

The present invention is made based on a different technical concept from JP '543, so the present invention cannot be derived from JP '543.

JP '543 does not disclose or suggest a steel sheet which is a high-strength, hot-rolled steel sheet having a ferritic structure containing TiC and/or NbC precipitates with the steel sheet being excellent in hole expandability, ductility and having strength of at least 980 N/mm^2 without containing Mg.

U.S. Patent No. 5,470,529 ("US '529")

US '529 relates to a high tensile strength steel sheet having improved formability and discloses a steel sheet consisting essentially, in terms of weight, C: 0.10 - 0.25%, Si < 1.0% (claim 1), Mn: 0.5 - 4%, Al: 0.1 - 2.0%, wherein $1.0 \leq Si\ (\%) + Al\ (\%) \leq 2.5$, Cu: 0.1 - 2.0%, Ni: 0 - 1.0% and $Ni\ (\%) \geq Cu\ (\%)/3$, Cr: 0 - 5.0%, Ca: 0 - 0.01%, Zr: 0 - 0.10%, REM: 0 -0.10%, Nb: 0 - 0.10%, Ti: 0 - 0.10%, V: 0 - 0.20%, and a balance of Fe and inevitable impurities with N being limited to 0.01 or less, the steel sheet having at least 5% by volume of retained austenite and $Cu\ (\%) \geq Si(\%)$.

However, in order to obtain residual austenite, in US '529, the Al content and the Si content are limited to the range shown in Fig. 1 (column 4, lines 46 to 47) and (column 5, lines 48 to 54).

On the other hand, in the present invention, Al is added as a deoxidizing agent and for promoting ferrite formation (page 5, line 31 to page 6 line 3) and not for promoting residual austenite formation.

Therefore, in order to clarify the technical concept of the present invention, the upper limit of the Al content of claims has been amended to 0.04% based on the Example shown in Table 1 as previously discussed.

The structure of the steel sheet of the present invention does not contain residual austenite like US '529, so the steel sheet of the present invention is different from that of US '529 in structure.

The present invention cannot be derived from US '529, even if US '529 describes additional elements recited in the present invention.

It is therefore submitted that amended independent claims 1 and 2 are patentable over JP '543 alone or in combination with US '529.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

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